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Multiple Logistic Regression Analysis of Factors Influencing Vitamin A Deficiency among Under-Five Children in Bangladesh

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Abstract

Vitamin A deficiency is the leading cause of preventable childhood blindness and increases the risk of death from common childhood illnesses such as diarrhea. The objective of this study was to investigate the vitamin A deficiency among under-five children in Bangladesh. The secondary data was used in this study that was extracted from a cross-sectional survey which had been done by Bangladesh Demographic and Health Survey (BDHS-2014). Frequency distribution, Chi-square test and multiple binary logistic regression model were selected were used to determine the prevalence and associated factors of vitamin A deficiency respectively among under-five children in Bangladesh. The prevalence of providing vitamin A in last 6 months among children aged 6-59 months in Bangladesh was 59.2% (urban 61.3% and rural 57.6%). Parents living in Chittagong were more preferable to provide vitamin A to their children than people living in Rajshahi division (AOR=0.809; 95% CI:0.671-0.976; $p<0.05$). Non-Muslim people were more preferable to provide vitamin A to their children than Muslim (AOR=1.212; 95% CI:1.001-1.468; $p<0.05$). Rich people was preferred to provide vitamin A to their children than poor [AOR=0.836; 95% CI: 0.714, 0.977; $p<0.05$], children who got measles were more likely to receive vitamin A than child who did not receive measles [AOR=0.279; 95% CI: 0.240, 0.323; $p<0.05$], mother who paid visit for 1-3 times antenatal care during pregnancy were more likely to provide vitamin A to their children than mother

who did not pay any visit for antenatal care AOR=1.425; 95% CI: 1.219, 1.665; $p<0.01$]. The Hosmer-Lemeshow test demonstrated that our model was good fitted to the data. A remarkable number of children in Bangladesh were suffering from vitamin A deficiency. Some factors were found as the predictors of vitamin A deficiency. Government of Bangladesh should special take care of under-five children health issue.

Keywords: Bangladesh, Under-five children, Vitamin A deficiency, Chi-square test, Multiple binary logistic regression.

AMS Classification: 62P10.

1. Introduction

Micronutrient is one of the groups of nutrients including vitamins and minerals. At least cobalt, iron, iodine, chromium, selenium, copper, manganese, zinc, and molybdenum are included in micro-minerals. Micro-minerals play an important role in growth, bone health, fluid balance and several other processes. On the other hand, A, C, D, E, and K, choline, and the B vitamins are included in vitamin of micronutrient. Vitamins are necessary for energy production, immune function, blood clotting and other functions; also vitamins are substances that our bodies need to develop and function normally (Gernand et al., 2016).The gathered nations identified iodine, iron, and vitamin A were deficiencies for children in two micro-minerals and one micronutrient respectively in World Summit for children at 1990. At that time the problem had been found especially in developing countries (UNICEF, 1998). The Summit was held for eradication of these deficiencies. Human body needs smaller amounts of micronutrients relative to macronutrients. That's why they're called "micro." They are needed only in minuscule amount, these substances are the "magic wands" that enable the body to produce enzymes, hormones and other substances essential for proper growth and development. As tiny as the amounts are, however, the consequences of their absence are severe. While they are only required in tiny quantities, micronutrients are the essential building blocks of healthy brains, bones and bodies. Humans must attain micronutrients from food since human body cannot generate vitamins and minerals for the most part. That's why they're also referred to as essential nutrients.

The lack of essential vitamins and minerals required in small amounts by the body for proper growth and development is called micronutrient deficiency. Micronutrient deficiency are often referred to as 'hidden hunger' because they develop gradually over time, their devastating impact not seen until irreversible damage has been done. Micronutrient deficiency is a major contributor to childhood morbidity and mortality. It's the reason of poor physical and mental development in children, vulnerability or exacerbation of disease, mental retardation, blindness and general losses in productivity and potential. MND are underlying causes of disease, with impact on the quality of life, morbidity and mortality of populations, and threatening health and wellbeing globally (Tulchinsky, 2010). Children can take delivery of micronutrients from foods, fortified food, and direct supplementation. An estimated 250 million preschool children are vitamin A deficient and among of them 2, 50,000 to 5, 00,000 children become blind every year. One third of vitamin A deficient children are living in sub-Sahara Africa and South Asia (Gogia and Sachdev, 2011).Our planet's population is still affected by many food related challenges including vitamin and minerals deficiencies. That's why the theme of World Health Day 2005 was healthy mothers and child and the slogan was "*Make every mother and child count"* (WHO, 2005). The National Micronutrients Status Survey 2011-2012 represents that the prevalence of vitamin A deficiency were 20.5% in preschool age children and the prevalence of iron deficiency is 10.7% in preschool age children (National Micronutrients Status Survey, 2011-2012). A systematic review of vitamin A supplementation in children aged 6-59 months showed a 24% reduction in all-cause mortality and a 28% reduction in diarrhoea-related mortality (Ahmed, 2016). Vitamin A is an essential micronutrient for the normal function of the visual system, for growth, development as well as for immune function and reproduction (Bhan& Bhandari, 1998; WHO, UNICEF & IVACG, 1997; WHO, 1998b; WHO & UNICEF, 1998). Supplementation of vitamin A diminished child mortality by 23 percent in children age 6 months to 5 years in vitamin A deficient areas (Beaton et al. 1993). This indicates that low body vitamin A, even without explicit clinical indicators, has important health consequences, mainly on the outcome of important infections (Beaton et al. 1993). More than half of preschool children are anemic, and an estimated 75 million and 140 million preschool children have clinical and subclinical vitamin A deficiencies respectively in developing countries (Juan, 2003). Several micronutrients including zinc, iron, and vitamin A are associated with immune function and risk of morbidity, which

in turn affect growth (Juan, 2003). Bangladesh Demographic and Health Survey 2014 (NIPORT, 2014) reported that rural children(66%) consume less vitamin A-rich foods than urban children(68%) does, also educated mothers are more likely to give their children (76%) vitamin A-rich foods than uneducated mothers. In children intensity of infections like measles and diarrheal diseases can be increased by Vitamin A Deficiency (VAD). It alleviates our immune system and reduces our healing power from sickness. For this reasons the Government of Bangladesh has taken an essential step to overcome VAD by distributing vitamin A capsules to children age 6-59 months. Since February 2011 children age 9-11 months are no longer provided vitamin A supplementation at the time they receive the measles vaccination. In Bangladesh 62% children had given vitamin A supplementation whose age 6-59 months (NIPORT, 2014). The coverage of vitamin A supplementation rise from 60% to 62% at the time being from 2011 to 2014 but it appears inadequate to accomplish HPNSDP target of 90 percent by 2016 (NIPORT, 2014). In Bangladesh only 4 percent of children received iron supplementation whose age range from 6 to 59 months in 2014 (NIPORT, 2014). 40 percent of children age 6-59 months received deworming medication in 2014 in Bangladesh (NIPORT, 2014). The Government of Bangladesh has achieved 8 goals under Millennium Development Goals (MDGs) among of these there is some health related goals such as child mortality, maternal health, HIV/AIDS, and malaria, and it has finished in 2015. Now the Government of Bangladesh is working toward achieving Sustainable Development Goals (SDGs) by 2030.To the best of our knowledge most of the studies with under five children micronutrient deficiency have been done with other populations, but this type study are poorly documented with Bangladeshi children.

Research Questions: The major research questions related to this study are following as,

(i) How many under-five children were suffering from vitamin A deficiency in Bangladesh?
(ii) Was there any effect of parents' demographic and socio-economic factors on vitamin A deficiency in Bangladesh?

On the basis of research questions, the aim of this study was to determine the prevalence and associated factors of micronutrient deficiency among under-five children in Bangladesh.

2. Materials and Methods

Setting and participants: This study was a cross-sectional study and data for this study was extracted from Bangladesh Demographic and Health Survey (BDHS-2014). The national-level survey data was collected from May 21 to August 17, 2014 from Bangladeshi married women in reproductive age (15 to 49 years). All information regarding subject and characteristics has been described elsewhere (NIPORT, 2014).

Inclusion criteria: In this study, we considered only children aged 6-59 months and he/she was not suffering from a serious disease, they were born in Bangladesh, and their mothers who did not have any mental diseases.

Sample selection procedure: As I mentioned in inclusion criteria, in this study only considered non-pregnant mothers who had at least one child aged 6-59 months living with mothers. Present author checked the outliers of dataset, and she removed the outliers, also removed missing values and incomplete data, after removing the abnormal values of data, finally 6678 samples were considered for analysis in the present study (Fig.1).

Outcome variable: Outcome variables are usually the dependent variables which are observed and measured by changing independent variables. The outcome variable in this study was micronutrients status that was children consumed foodstuffs abounding in vitamin A and iron, vitamin A and iron supplementation, and having deforming medication. Our sample was classified into two classes based on micronutrient deficiency (MD) such as, (i) Yes = 1 (having MD), and (ii) No = 0 (not having MD). BDHS-2014 asked to mothers, (i) "Did you provide vitamin A to your children in last six months?", and (ii) "Did you provide iron supplementation to your children in last six months?"

Independent variables: Some selected socio-economic, demographic, anthropometric and behavioral factors were considered as independent variables in this study. Most of the selected independent variables for this study had been selected on the basis of previous study and available in NIPORT (2014) (Faruk et al. 2016).

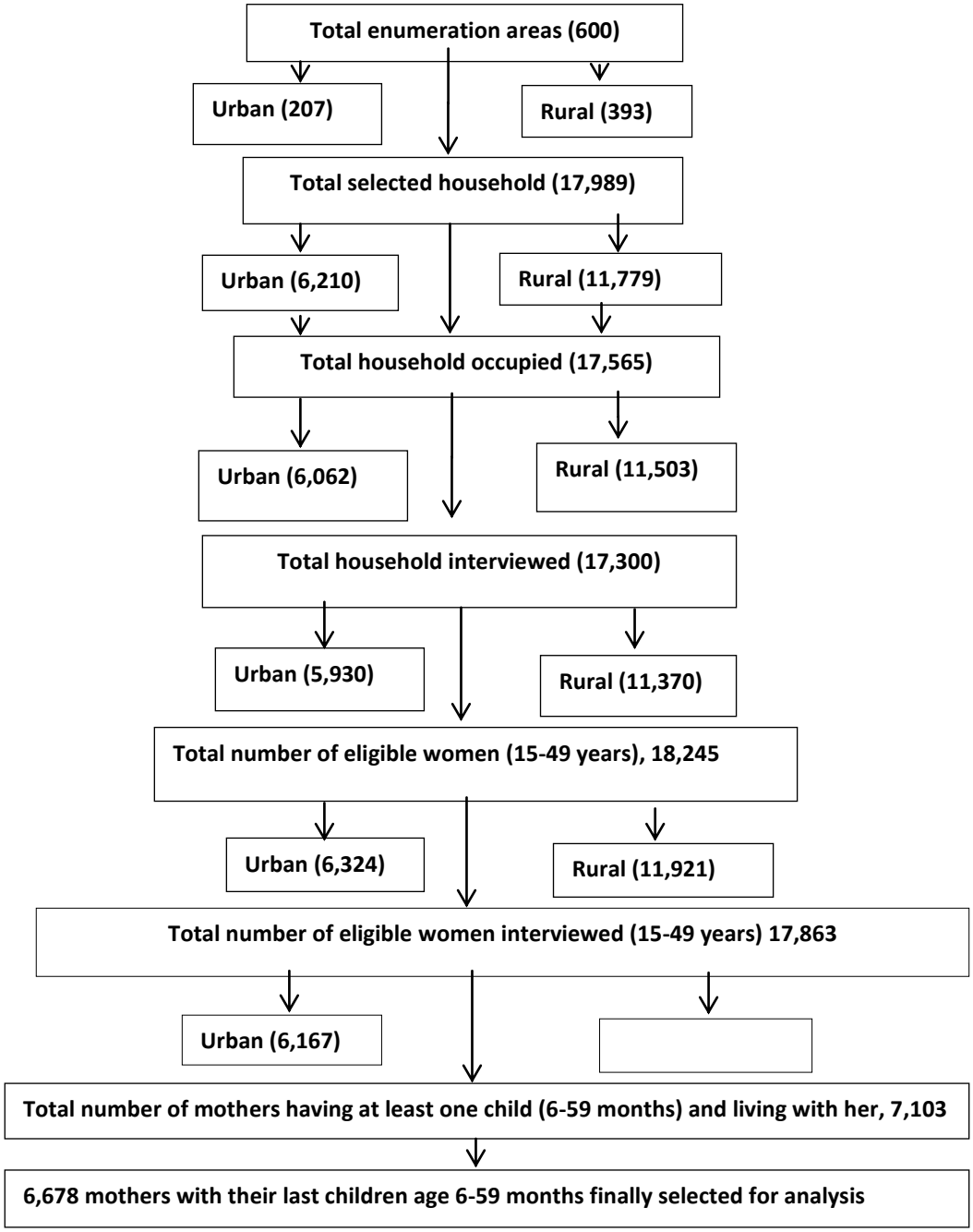

Figure 1: Sample selection procedure

Statistical analysis: First, we used frequency distribution to determine the prevalence of micronutrient deficiency among children aged 6-59 months in Bangladesh. Second, we selected bivariate analysis, and the Chi-square (χ^2) test was used to find the significant association between two categories variables in here between outcome and each selected categorical variable. From this test, we selected independent variables for binary multiple logistic regression model. Only significant variables were selected as independent variable. Multiple binary logistic regression model was applied to identify the effects of the significant factors on micronutrient deficiency. SPSS (IBM, Version 23) and STATA (Version, 13) software was utilized to analyze our data. We consideredthe value of p less than 0.05 as statistically significant in this analysis.

3. Results

A total number of 6678 samples were considered in this study to investigate the micronutrient deficiency among under five children in Bangladesh.

Providing vitamin A in last 6 months among under-five children in Bangladesh

It was noted that the percentage of child who received vitamin A in last 6 months was 59.2% in Bangladesh (Table 1).

Chi-square test: It was observed that the highest number of children received vitamin A who were living in Rangpur division (63.5%) then followed by Barisal (60.3%), Chittagong (60%), Dhaka (59.8%), Khulna (59.3%), Rajshahi (54.7%) and Sylhet (53.8%) division. Chi-square test showed that the association between living locations and providing vitamin A to children was significant ($p<0.01$). The highest number of children lived in rural area (67.6%) and 32.4% child lived in urban area. It was observed that the highest number of children received vitamin A in last 6 months who were living in urban area (61.3%) and in rural area (57.6%). Since the p-value was less than 0.01 so our test was significant that means there was an association between place of residence and receiving vitamin A in last 6 months among under five children. It was observed that the highest number of women have completed their secondary (46.7%) level of education then followed by primary (27.2%), no education (15.0%) and higher education (11.2%). It was found that the higher educated mother provided vitamin A in last 6 months to their child most (64.4%) then followed by secondary (61.6%),

primary (54.9%), uneducated (52.8%). The Chi-square test demonstrated that there was an association between highest education level and providing vitamin A in last 6 months among under five children since p-value<0.01. We observed that higher number of children came from Muslim community (91.6%) than non-Muslim community (8.4%). It was observed that the highest number of children received vitamin A in last 6 months who belonged from non-Muslim community (64.7%) and in Muslim community (58.2%). Since the p-value was less than 0.01 so our test was significant that means there was an association between religion and providing vitamin A in last 6 months among under five children. We observed that highest number of children came from rich family (41.0%) then followed by poor (39.5%) and middle class (19.5%). It was observed that rich people provided vitamin A in last 6 months to their child most (63.4%) then followed by middle class people (59.6%) and poor people (53.6%). The Chi-square test demonstrated that there was an association between wealth index and providing vitamin A in last 6 months among under five children since p-value<0.01. It was observed that higher number of people use hygienic toilet (62.7%) than unhygienic toilet (37.3%). We found that the highest number of people provided vitamin A in last 6 months to their children who use hygienic toilet (61.4%) in compare to people who use unhygienic toilet (54.3%).The Chi-square test demonstrated that there was an association between type of toilet facility and providing vitamin A in last 6 months among under five children since p-value<0.01. It was observed that the highest number of respondents husband were hard worker (67.9%) who participate in the study then followed by businessman (22.6%), service holder (6.7%) and unemployed (2.8%). It was found that service holder father were more likely to provide vitamin A in last 6 months to their children (68.8%) then followed by businessman (61.0%), unemployed (59.8%) and hard worker (57.0%). The Chi-square test demonstrated that there was an association between husbands occupation and providing vitamin A in last 6 months among under five children since p-value<0.01. It was observed that maximum respondents weight were normal (57.8%) then followed by undernourished (22.8%) and over-nourished (19.3%). Over-nourished respondents (64.1%) were more likely to provide vitamin A in last 6 months to their children then followed by normal weight (58.9%) and undernourished (54.0%). The Chi-square test demonstrated that there was an association between respondents body mass index and providing vitamin A in last 6 months among under five children since p-value<0.01. It was observed that most of the respondents gave birth to their first child at early age

(81.1%) than normal age (18.9%). Respondents who gave birth to their first child at normal age (62.3%) were more likely to provide vitamin A in last 6 months to their children than early age (58.0%). The Chi-square test demonstrated that there was an association between age of respondents first birth and providing vitamin A in last 6 months among under five children since p-value<0.01. This study was showed that 35.5% family in Bangladesh was consisted with 5 to 6 members then followed by less than 4 to 4 (≤4) members (33.6%) and 7 to above (31.0%). It was observed that family consisted with less than 4 to 4 (≤4) members provided vitamin A in last 6 months to their children most (60.7%) then followed by 5 to 6 (59.0%) and 7 to above (56.5%). The Chi-square test demonstrated that there was an association between number of family member and providing vitamin A in last 6 months among under five children since p-value<0.05. This study was showed that most of the children lived with respondents (99.1%) than lives elsewhere (0.9%). It was observed that children who lived with respondents (59.0%) were more likely to have vitamin A in last 6 months than children who lived elsewhere (35.6%). The Chi-square test demonstrated that there was an association between child lives with whom and having vitamin A in last 6 months among under five children since p-value<0.01. This study was showed that he highest number of father have completed their secondary (30.7%) level of education then followed by primary (29.8%), no education (24.4%) and higher education (15.1%). It was found that the higher educated father provided vitamin A in last 6 months to their child most (66.2%) then followed by secondary (61.4%), primary (55.4%), uneducated (54.9%).The Chi-square test demonstrated that there was an association between husbands education level and providing vitamin A in last 6 months among under five children since p-value<0.01. This study was showed that most of the children received measles (71.5%) than who did not receive measles (21.5%). Children who received measles had vitamin A in last 6 months most (67.7%) than who did not receive (36.3%). The Chi-square test demonstrated that there was an association between received measles and having vitamin A in last 6 months among under five children since p-value<0.01. This study was showed that most of the children did not receive measles at 15 months (50.1%) than who received measles at 15 months (49.9%). Children who received measles at 15 months had vitamin A in last 6 months most (67.5%) than who did not receive measlesat 15 months (50.0%). The Chi-square test demonstrated that there was an association between received measles at 15 months and having vitamin A in last 6 months among under five children since p-value<0.01. It was observed

that most of the mother did not provide supplements like eggs (76.4%), meats (89.5), fish or shellfish (70.5%), mangoes, papayas, other vitamin A fruits (87.1%) to their child than who provided. Women who provided supplements like eggs, meats, fish or shellfish, mangoes, papayas, other vitamin A fruits less or in small amounts to their child were more likely to provide vitamin A in last 6 months to their child with respective percentage 66.2%, 69.7%, 64.2%, 60.5% than who provided supplements. The Chi-square test demonstrated that there was an association between providing supplements and providing vitamin A in last 6 months among under five children since p-value<0.01. This study was showed that most of the women's last delivery cost was <20,000 (44.6%) then followed by <1200 (34.9%), nothing (11.3%) and ≥20,000 (9.2%). Women whose last delivery cost was <20,000 provided vitamin A in last 6 months to their child most (58.2%) than others. The Chi-square test demonstrated that there was an association between cost of last delivery and providing vitamin A in last 6 months among under five children since p-value<0.01. It was observed that most of the child's size at birth was normal (80.7%) than low (19.3%). Normal size child had vitamin A in last 6 months most (56.5%) than low size child (50.5%). The Chi-square test demonstrated that there was an association between size of child at birth and having vitamin A in last 6 months among under five children since p-value<0.01. This study was showed that most of the child had their vaccination (85.4%) than who hadn't (14.6%). Children who had their vaccination had vitamin A in last 6 months most (60.5%) than who hadn't (14.4%). The Chi-square test demonstrated that there was an association between ever had vaccination and having vitamin A in last 6 months among under five children since p-value<0.01. It was observed that mother who visited for antenatal care during pregnancy most was 1 to 3 times (46.7%) then followed by 4 to above times (32.2%) and no antenatal (21.2%). Mother who visited for antenatal care 4 to above times during pregnancy were more likely to provide vitamin A in last 6 months to their child most (60.8%) then followed by 1 to 3 times (55.5%) and no antenatal (46.6%). The Chi-square test demonstrated that there was an association between number of antenatal care during pregnancy and providing vitamin A in last 6 months among under five children since p-value<0.01. It was observed that most of the children's nutritional status were normal 80.2% then followed by over-nutrient (14.6%) and under-nutrient (5.2%). Children who were over-nutrient were more likely to receive vitamin A in last 6 months (65.8%) then followed by normal nutrient (60.9%) and under-nutrient (14.6%). The Chi-square test demonstrated that there was an

association between nutritional status of children and receiving vitamin A in last 6 months among children aged 6-59 months since p-value<0.01 (Table 1).

Table 1: Association between independent variable and providing vitamin A in last 6 months to under-five children in Bangladesh

Providing Vitamin A in last 6 months				
Division, N(%)	No, N(%)	Yes, N(%)	Chi-square	p-value
Barisal, 800(12.0)	318(39.8)	482(60.3)	25.742	0.0001
Chittagong, 1251(18.7)	501(40.0)	750(60.0)		
Dhaka, 1196(17.9)	481(40.2)	715(59.8)		
Khulna, 757(11.3)	308(40.7)	449(59.3)		
Rajshahi, 836(12.6)	379(45.3)	457(54.7)		
Rangpur, 855(12.8)	312(36.5)	543(63.5)		
Sylhet, 983(14.7)	454(46.2)	529(53.8)		
Type of place of residence, N(%)				
Urban, 2162(32.4)	836(38.7)	1326(61.3)	8.627	0.003
Rural, 4516(67.6)	1917(42.4)	2599(57.6)		
Highest education level, N(%)				
No education, 999(15.0)	472(47.2)	527(52.8)	46.699	0.0001
Primary, 1817(27.2)	820(45.1)	997(54.9)		
Secondary, 3117(46.7)	1196(38.4)	1921(61.6)		
Higher, 745(11.2)	265(35.6)	480(64.4)		
Religion, N(%)				
Muslim, 6117(91.6)	2555(41.8)	3562(58.2)	8.891	0.003
Non-Muslim, 561(8.4)	198(35.3)	363(64.7)		
Wealth Index, N(%)				
Poor, 2641(39.5)	1226(46.4)	1415(53.6)	54.073	0.0001
Middle, 1301(19.5)	526(40.4)	775(59.6)		

Rich, 2736(41.0)	1001(36.6)	1735(63.4)		
Type of toilet facility, N(%)				
Hygienic, 4189(62.7)	1616(38.6)	2573(61.4)	32.517	0.0001
Unhygienic, 2489(37.3)	1137(45.7)	1352(54.3)		
Sex of child, N(%)				
Male, 3487(52.2)	1475(42.3)	2012(57.7)	3.481	0.062
Female, 3191(47.8)	1278(40.1)	1913(59.9)		
Place of delivery, N(%)				
Hospital/clinic delivery, 1749(26.2)	730(41.7)	1019(58.3)	0.258	0.612
Home delivery, 4929(73.8)	2023(41.0)	2906(59.0)		
Husbands/Partners occupation, N(%)				
Hard worker, 4532(67.9)	1949(43.0)	2583(57.0)	27.774	0.0001
service holder, 446(6.7)	139(31.2)	307(68.8)		
Businessman, 1511(22.6)	589(39,0)	922(61.0)		
Unemployed, 189(2.8)	76(40.2)	113(59.8)		
Respondents occupation, N(%)				
Non-housewife, 1803(27.0)	727(40.3)	1076(59.7)	0.832	0.362
Housewife, 4875(73.0)	2026(41.6)	2849(58.4)		
Total child ever born, N(%)				
1,2519(37.7)	1050(41.7)	1469(58.3)	5.361	0.147
2,2060(30.8)	810(39.3)	1250(60.7)		
3,1068(16.0)	446(41.8)	622(58.2)		
4-above, 1031(15.4)	447(43.4)	584(56.6)		
Currently residing with husband, N(%)				
staying elsewhere, 1018(15.2)	412(40.5)	606(59.5)	0.281	0.596
living with her, 5660(84.8)	2341(41.4)	3319(58.6)		
Respondent body mass index, N(%)				
Undernourished, 1525(22.8)	701(46.0)	824(54.0)	29.479	0.0001

Normal weight, 3862(57.8)	1589(41.1)	2273(58.9)		
Over-nourished, 1291(19.3)	463(35.9)	828(64.1)		
Age of respondent first birth, N(%)				
≤20 early child bearing, 5419(81.1)	2278(42.0)	3141(58.0)	7.829	0.005
>20 Normal age of child bearing, 1259(18.9)	475(37.7)	784(62.3)		
Number of family member, N(%)				
≤4, 2242(33.6)	881(39.3)	1361(60.7)	7.973	0.019
5-6, 2368(35.5)	972(41.0)	1396(59.0)		
7-above, 2068(31.0)	900(43.5)	1168(56.5)		
Child lives with whom, N(%)				
Respondent, 6619(99.1)	2715(41.0)	3904(59.0)	13.202	0.0001
Lives elsewhere, 59(0.9)	38(64.4)	21(35.6)		
Had diarrhea recently, N(%)				
Yes, last two weeks, 340(5.1)	148(43.5)	192(56.5)	0.785	0.376
No, 6338(94.9)	2605(4.1)	3733(58.9)		
Had fever in last two weeks, N(%)				
Yes, 2518(37.7)	1020(40.5)	1498(59.5)	0.857	0.355
No, 4160(62.3)	1733(41.7)	2427(58.3)		
Had cough in last two weeks, N(%)				
Yes, last two weeks, 2230(33.4)	944(42.3)	1286(57.7)	1.693	0.193
No, 4448(66.6)	1809(40.7)	2639(59.3)		
Husbands education level, N(%)				
No education, 1627(24.4)	733(45.1)	894(54.9)	47.733	0.0001
Primary, 1990(29.8)	887(44.6)	1103(55.4)		
Secondary, 2053(30.7)	792(38.6)	1261(61.4)		
Higher, 1008(15.1)	341(33.8)	667(66.2)		
Received measles, N(%)				

Yes, 4778(71.5)	1542(32.3)	3236(67.7)	555.426	0.0001
No, 1900(21.5)	1211(63.7)	689(36.3)		
Received measles at 15 months, N(%)				
Yes, 3334(49.9)	1082(32.5)	2252(67.5)	211.413	0.0001
No, 3344(50.1)	1671(50.0)	1673(50.0)		
Age at cohabitation, N(%)				
Early Marriage, 4809(72.0)	2024(42.1)	2785(57.9)	5.334	0.065
18-30, 1859(27.8)	725(39.0)	1134(61.0)		
late marriage, 10(0.1)	4(40.0)	6(60.0)		
Total	2753(41.2)	3925(58.8)		
Gave child eggs, N(%)				
No, 2258(76.4)	1245(55.1)	1013(44.9)	97.547	0.0001
Yes, 699(23.6)	236(33.8)	463(66.2)		
Gave child meat (beef, pork, lamb, chicken, etc) , N(%)				
No, 2647(89.5)	1387(52.4)	1260(47.6)	54.098	0.0001
Yes, 310(10.5)	94(30.3)	216(69.7)		
Gave child fish or shellfish, N(%)				
No, 2085(70.5)	1169(56.1)	916(43.9)	101.224	0.0001
Yes, 872(29.5)	312(35.8)	560(64.2)		
Gave child mangoes, papayas, other vitamin A fruits, N(%)				
No, 2577(87.1)	1331(51.6)	1246(48.4)	19.637	0.0001
Yes, 380(12.9)	150(39.5)	230(60.5)		
Total	1476(49.9)	1481(50.1)		
Cost of last delivery, N(%)				
Nothing, 493(11.3)	237(48.1)	256(51.9)	13.233	0.004
<1200, 1526(34.9)	723(47.4)	803(52.6)		

<20000, 1946(44.6)	814(41.8)	1132(58.2)		
≥20000, 403(9.2)	178(44.2)	225(55.8)		
Size of child at birth, N(%)				
Normal, 3526(80.7)	1535(43.5)	1991(56.5)	9.870	0.002
Low, 842(19.3)	417(49.5)	425(50.5)		
Total	1952(44.7)	2416(55.3)		
Ever had vaccination, N(%)				
No, 347(14.6)	297(85.6)	50(14.4)	252.678	0.0001
Yes, 2028(85.4)	802(39.5)	1226(60.5)		
Total	1099(46.3)	1276(53.7)		
Number of antenatal visit during pregnancy, N(%)				
No antenatal, 924(21.2)	493(53.4)	431(46.6)	44.926	0.0001
1-3, 2039(46.7)	908(44.5)	1131(55.5)		
4-above, 1404(32.2)	551(39.2)	853(60.8)		
Total	1952(44.7)	2415(55.3)		
When child put to breast, N(%)				
Yes, 2219(51.2)	1009(45.5)	1210(54.5)	1.091	0.296
No, 2112(48.8)	927(43.9)	1185(56.1)		
Total	2395(55.3)	1936(44.7)		
Nutritional status of children, N(%)				
Under nutrition, 329(5.2)	281(85.4)	48(14.6)	293.662	0.0001
Normal, 5066(80.2)	1980(39.1)	3086(60.9)		
Over nutrition, 920(14.6)	315(34.2)	605(65.8)		
Total	2576(40.8)	3739(59.2)		

Multiple binary logistic regression analysis: Since the standard error (S.E) of each independent variable was laid between the magnitude values of 0.001 and 0.5, there was no presence of multicollinearity problem among independent variables. Only we considered significant variables provided by Chi-square test as

independent variable in multiple binary logistic regression model. According to the fitted model there were 14 variables considered as the significant predictors in case of micronutrient deficiency among under five children in Bangladesh. Binary logistic regression model demonstrated that people who were living to Chittagong division were more likely to provide vitamin A in last 6 months to their child than people who were living in Rajshahi division [AOR=0.809; 95% CI: 0.671, 0.976; p<0.05]. From the table we observed that religion had significant effect on micronutrient deficiency. Non-Muslim mothers were more likely to provide vitamin A in last 6 months to their child than Muslim mothers [AOR=1.212; 95% CI: 1.001, 1.462; p<0.05]. We investigated that wealth index had significant effect on micronutrient deficiency with rich had more chance to provide vitamin A in last 6 months to their child than poor [AOR=0.836; 95% CI: 0.714, 0.977; p<0.05],body mass index had also significant effect on micronutrient deficiency with over-nourished mother were found to provide more vitamin Ain last 6 months to their child than undernourished [AOR=0.840; 95% CI: 0.709, 0.955; p<0.05], child lives with whom has also significant effect on micronutrient deficiency with child who were living with respondent were more likely to take vitamin A in last 6 months than child who were living elsewhere [AOR=0.370; 95% CI: 0.211, 0.648; p<0.01], child receiving measles had also significant effect on micronutrient deficiency with child who received measles were more likely to receive vitamin A in last 6 months than child who did not receive measles [AOR=0.279; 95% CI: 0.240, 0.323; p<0.01], supplementation of foods had also significant effect on micronutrient deficiency with child who did not eat egg were more likely to receive vitamin A in last 6 months than child who ate egg [AOR=0.526; 95% CI: 0.437, 0.634; p<0.01], child who did not eat meat were more likely to receive vitamin A in last 6 months than child who ate meat [AOR=0.517; 95% CI: 0.397, 0.673; p<0.01], child who did not eat fish were more likely to receive vitamin A in last 6 months than child who ate fish [AOR=0.530; 95% CI: 0.447, 0.628; p<0.01], child who did not eat mangoes, papayas, other vitamin A fruitswere more likely to receive vitamin A in last 6 months than child who ate mangoes, papayas, other vitamin A fruits [AOR=0.783; 95% CI: 0.622, 0.986; p<0.05], taking vaccination has also significant effect on micronutrient deficiency with child who ever received vaccination were more likely to receive vitamin A in last 6 months than child who did not receive vaccination [AOR=0.110; 95% CI: 0.081, 0.151; p<0.01], number of antenatal visit during pregnancy had also significant effect on micronutrient deficiency with mother who went for 1-3 times antenatal visit during pregnancy were more likely to provide vitamin A in last 6 months to their child than mother who did not go for any antenatal visit during pregnancy [AOR=1.425; 95% CI: 1.219, 1.665; p<0.01], also mother who went for 4-above times antenatal visit during pregnancy

were more likely to provide vitamin A in last 6 months to their child than mother who did not go for any antenatal visit during pregnancy [AOR=1.771; 95% CI: 1.497, 2.094; p<0.01], size of child at birth had also significant effect on micronutrient deficiency with normal size of child at birth were more likely to receive vitamin A in last 6 months than low size of child at birth [AOR=0.786; 95% CI: 0.676, 0.913; p<0.01]. In our study, Hosmer-Lemeshow test (Chi-square value=6.312, p-value=0.612) showed that the selected binary multiple logistic model was well-fitted for the data since p-value>0.05 (Table 2).

Table 2: Result of multiple binary logistic regression analysis of the effect of socioeconomic and demographic factors on micronutrient deficiency (taking vitamin A in last 6 months)

Variable	B	S.E.	Wald	df	p-value	AOR	95% C.I. for AOR	
							Lower	Upper
Division			16.663	6	0.011			
Barisal vs Chittagong[R]	0.132	0.099	1.778	1	0.182	1.141	0.940	1.386
Dhaka vs Chittagong[R]	-0.005	0.087	0.003	1	0.958	0.995	0.839	1.181
Khulna vs Chittagong[R]	-0.053	0.099	0.286	1	0.593	0.948	0.781	1.151
Rajshahi vs Chittagong[R]	-0.212	.096	4.904	1	0.027	0.809	0.671	0.976
Rangpur vs Chittagong[R]	0.166	0.098	2.865	1	0.091	1.180	0.974	1.429
Sylhet vs Chittagong[R]	-0.001	0.093	0.000	1	0.992	0.999	0.833	1.199
Residence								
Urban vs Rural[R]	0.026	0.063	0.171	1	0.679	1.026	0.907	1.161
Highest education level			3.506	3	0.320			
No education vs higher[R]	-0.011	0.134	0.007	1	0.936	0.989	0.760	1.287
Primary vs higher[R]	0.013	0.122	0.011	1	0.915	1.013	0.798	1.286
Secondary vs higher[R]	0.111	0.107	1.079	1	0.299	1.117	0.906	1.377
Religion								
Non-Muslim vs Muslim[R]	0.192	0.098	3.876	1	0.049	1.212	1.001	1.468
Wealth Index			5.441	2	0.066			
Poor vs Rich[R]	-0.180	0.080	5.044	1	0.025	0.836	0.714	0.977
Middle vs Rich[R]	-0.056	0.080	0.492	1	0.483	0.945	0.808	1.106
Type of toilet facility								
Un-hygienic vs Hygienic[R]	-0.074	0.059	1.591	1	0.207	0.929	0.828	1.042

Husband occupation			2.864	3	0.413			
Service holder vs Hard worker[R]	0.225	0.135	2.765	1	0.096	1.252	0.961	1.632
Businessman vs Hard worker[R]	0.041	0.066	0.392	1	0.531	1.042	0.916	1.186
Unemployed vs hard worker[R]	0.005	0.160	0.001	1	0.973	1.005	0.735	1.376
Respondent body mass index			4.462	2	0.107			
Undernourished vs Over-nourished[R]	-0.174	0.087	4.060	1	0.044	0.840	0.709	0.995
Normal weight vs Over-nourished[R]	-0.066	0.073	0.817	1	0.366	0.936	0.812	1.080
Age of respondent 1st birth								
Normal age of child bearing vs Early child bearing[R]	0.056	0.074	0.573	1	0.449	1.057	0.915	1.222
Child lives with whom								
Lives elsewhere vs Respondent[R]	-0.994	0.286	12.087	1	0.001	0.370	0.211	0.648
Husband education level			2.830	3	0.419			
No education vs Higher[R]	-0.072	0.122	0.349	1	0.555	0.930	0.732	1.182
Primary vs Higher[R]	-0.147	0.112	1.702	1	0.192	0.864	0.693	1.076
Secondary vs Higher[R]	-0.045	0.103	0.192	1	0.661	0.956	0.780	1.170
Received measles at 15 month								
Yes vs No[R]	-0.017	0.068	0.064	1	0.800	0.983	0.859	1.124
Received Measles								
No vs Yes[R]	-1.278	0.075	287.574	1	0.0001	0.279	0.240	0.323
Gave child egg								
Yes vs No[R]	-0.642	0.095	45.854	1	0.0001	0.526	0.437	0.634
Gave child meat								
Yes vs No[R]	-0.659	0.134	24.052	1	0.0001	0.517	0.397	0.673
Gave child fish								
Yes vs No[R]	-0.635	0.087	53.579	1	0.0001	0.530	0.447	0.628
Gave child mangoes, papayas, other vitamin A fruits								

Yes vs No[R]	-0.244	0.118	4.326	1	0.038	0.783	0.622	0.986
Ever had vaccination								
No vs Yes[R]	-2.206	0.159	191.389	1	0.0001	0.110	0.081	0.151
No of antenatal visit during pregnancy			44.574	2	0.000			
1-3 vs No antenatal[R]	0.354	0.080	19.786	1	0.0001	1.425	1.219	1.665
4-above vs No antenatal[R]	0.571	0.086	44.512	1	0.0001	1.771	1.497	2.094
Size of child at birth								
Low vs Normal[R]	-0.241	0.077	9.845	1	0.002	0.786	0.676	0.913
Cost of last delivery			13.217	3	0.004			
Nothing vs ≥20000[R]	-0.157	0.135	1.359	1	0.244	0.855	0.656	1.113
<1200 vs ≥20000[R]	-0.129	0.113	1.319	1	0.251	0.879	0.705	1.096
<20000 vs ≥20000[R]	0.095	0.110	.749	1	0.387	1.100	0.886	1.366
Constant	0.902	0.151	35.423	1	0.000	2.464		
Goodness of fit	Hosmer and Lemeshow Test				Chi-square value=6.312		p-value=0.612	

N.B: B=Co-efficient, OR= Adjusted Odds Ratio, CI=Confidence interval, S.E =Standard error, df=Degrees of freedom and R=reference case.

ROC Curve for vitamin A: ROC was used to measure the accuracy of a test. The accuracy was measured by the area under the ROC curve. The area of this ROC curve was 0.669, by which we could say that in almost 70% of all possible pairs of subjects in which one had taken vitamin A in last 6 months and one had not taken vitamin A in last 6 months. This model would assign a higher probability to the subject with taken vitamin A in last 6 months (Fig.2).

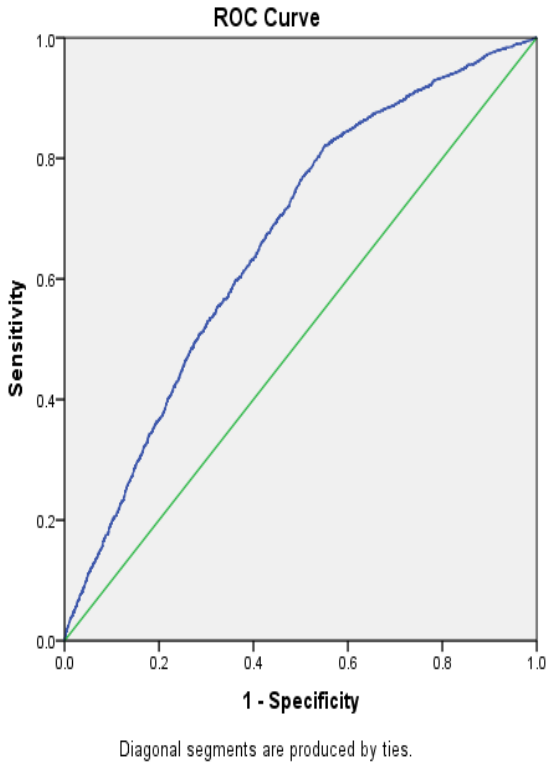

Figure 2: ROC curve for vitamin A

4. Discussion

In this study we investigated vitamin A deficiency among children aged 6-59 months in Bangladesh. As far as I know this data was never used before in such kind of study. So we interested to use this data for our study. In Bangladesh previous studies have examined the micronutrient deficiencies among children and women (Faruk et al., 2016),vitamin A deficiency and determinants of vitamin A status in Bangladeshi children and women (Rahman et al., 2016),the Factors affecting low coverage of the vitamin A supplementation program among young children admitted in an urban diarrheal treatment facility (Mostafa et al., 2019).The first study was a comprehensive review which provided the current situation of micronutrient deficiencies among children and women in Bangladesh. The current study may be the first to determine the prevalence of micronutrient deficiency among children aged 6-59 months in Bangladesh and also to examine

the association between socioeconomic, demographic factors and micronutrient deficiency among children aged 6-59 months in Bangladesh.

Vitamin A in last 6 months: In our study we found that 40.8% children did not receive vitamin A in last 6 months. The prevalence of vitamin A deficiency among preschool-age children in Bangladesh were 20.5% (Faruk et al., 2016) and 20.5% (Rahman et al., 2016). According to the other countries 10% children were suffering from vitamin A deficiency in Nepal (Schulze et al., 2014), 56.5% children were anemic in Mexico (Nancy et al., 2009), 52.6% children were vitamin A deficient in Pakistan (Habib et al., 2016), 12.0% children were suffering from vitamin A deficiency in Vietnam (Khan et al.,2006).

Effect of socio economic demographic factors on vitamin A in last 6 months: In our present study looking at the whole sample population, we noticed that the significant variables were living location, religion, wealth index, respondent body mass index, child lives with whom, received measles, supplementation of foods like (egg, meat, fish, mangoes, papayas, other vitamin A fruits), ever had vaccination, number of antenatal visit during pregnancy, size of child at birth. All of these significant variables came from multiple binary logistic regressions. It was observed that people living in Chittagong were more likely to provide vitamin A in last 6 months to their child than people living in Rajshahi division. Non-Muslim people were more likely to provide vitamin A in last 6 months to their child than Muslim people. Rich people were more likely to provide vitamin A in last 6 months to their child than poor people. People who provided food supplements like meat, fish, egg, mangoes, papayas, other vitamin A fruits in small amounts were more likely to provide vitamin A in last 6 months to their child than who provided more these supplements.Same findings had been found in Nepal study, they showed that lack consumption of vitamin A rich foods can lead to VAD (Schulze et al., 2014), which did not support our result.

Strength of the study: Our present study examined the prevalence of micronutrient deficiency among children aged 6-59 months in Bangladesh. This study also examined the associated factors and the effect of factors on micronutrient deficiency. There was a few study on micronutrient deficiency have been performed in Bangladesh. Most of the studies were on vitamin A deficiency (VAD). In our study we worked on under five children and we considered all Bangladeshi population. Very few studies have been conducted on this population group in others countries also. This is the major strength of our study. We have

also selected appropriate statistical method on the nature of data to examine the risk factors of micronutrient deficiency, which was also the strength of our study.

Limitation of the study: The strength of this study has been discussed in above, but there were many limitations of this study since secondary data had been used for this analysis. The foremost limitation of this study was a cross-sectional study. It was difficult to build up a causal relationship between socio-demographic, demographic and anthropometric factors and micronutrient deficiency among children aged 6-59 months in Bangladesh. A large number of subjects dropped out of this study, probably due to its limited duration. In our study, we could not select our independent variables willingly. Many factors are related to micronutrient deficiency like iodine, zinc, vitamin D but we could not take these because these factors were not available in BDHS-2014. We could not use blood sample data which could provide more accurate result about micronutrient.

5. Conclusions

In our present study we investigated the micronutrient deficiency among children aged 6-59 months in Bangladesh. We selected 6678 married women at their reproductive age (15-49 years) as sample for our study. More than 41% children did not receive vitamin A in last 6 months. Chi-square test demonstrated that living location, type of place of residence, mother's education level, religion, wealth index, type of toilet facility, father's occupation, respondent BMI, age of respondent first birth, child lives with whom, father's education level, received measles, received measles at 15 months, size of child at birth, number of antenatal visit during pregnancy, cost of last delivery, ever had vaccination, food supplements and child nutritional status were significantly associated with providing vitamin A in last 6 months. The multiple logistic model demonstrated that the influencing factors of providing vitamin A in last 6 months were living location, religion, wealth index, mother's BMI, child lives with whom received measles, food supplements, ever had vaccination, size of child at birth, number of antenatal visit during pregnancy. The Hosmer-Lemeshow test provided the following results, this test showed that the selected multiple binary logistic models was well-fitted for the data (Chi-square value=6.312, p-value=0.612) for providing vitamin A in last 6 months among children aged 6-59 months. ROC curve showed that about 70% all possible pairs of subjects in which one was provided vitamin A in last 6 months to their children and one did not provide.

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